

## **The Spacecraft Configuration Testing Collection, 1971-1977**

**6.0 cubic feet**

**JPL 159**

### **History**

Project Voyager, originally called “Mariner Jupiter/Saturn 1977” was approved by NASA and the U.S. Congress in June 1972. It was renamed Voyager in March 1977. Voyager was a dual spacecraft long-range mission that conducted a “Grand Tour” of the Outer Planets, visiting Jupiter, Saturn, Uranus, Neptune, as well as numerous planetary satellites, and continued beyond to the outer reaches of the Solar System. The project was managed by the Jet Propulsion Laboratory (JPL).

Project Viking to Mars was originally approved in 1968, after the cancellation of an over-ambitious Mars mission called Voyager (not to be confused with the later Voyager Project). Project Viking consisted of two orbiters and two landers. JPL was assigned to design and build the two Viking Orbiters. Overall responsibility for the management of Project Viking was at NASA’s Langley Research Center at Hampton, VA. Viking 1 was launched on August 20, 1975, and the Viking 1 Lander touched down on the surface of Mars on July 20, 1976. Viking 2 was launched in September 1975, with the Lander landing on Mars in September 1976.

Helios was a joint space flight mission between the United States and the Federal Republic of Germany to investigate the innermost parts of the Solar System. It was the first multi-national space exploration project. Helios 1 and 2 were the first two missions to venture inside the orbit of Mercury. Helios 1 was launched on December 10, 1974, and Helios 2 was launched on January 15, 1976. While Helios 2 suffered a catastrophic failure in March 1980, Helios 1 continued gathering scientific data about plasma waves in the Solar Wind until the early 1990s.

### **Provenance**

The collection originated from three different shipments of records from various offices at JPL to the JPL Laboratory Records Center (LRC). These shipments, and other unrelated material, were combined into one accession when they were transferred to the JPL Archives.

Shipment 3677; (2 c.f. unprocessed): This shipment originated from the office of Gary Brownlee, Section 354, Applied Mechanics Technology. At an undisclosed time, it was transferred from Brownlee to Marc Trubert, Section 354. It was transferred from Trubert to the Federal Records Center in Laguna Niguel, CA on April 5, 1977. The shipment was then transferred to the JPL LRC in January 1983 and from the LRC to the JPL Archives in 1989.

Shipment 4266; (5 c.f. unprocessed): This shipment originated from the office of Gary Brownlee, Section 354, Applied Mechanics Technology. At an undisclosed time, it was transferred from Brownlee to Marc Trubert, Section 354. It was transferred from Trubert to the Federal Records Center in Laguna Niguel, CA on January 19, 1978. The shipment was then transferred to the JPL LRC in January 1983 and from the LRC to the JPL Archives in 1989.

Shipment 7350; (3 c.f. unprocessed): This shipment was transferred to the JPL Laboratory Records Center from the office of James A. Hendrickson, Section 354, Applied Mechanics Technology, on July 22, 1983. It was transferred from the LRC to the JPL Archives in May 1988.

### **Collection Arrangement and Description**

The collection documents various test configurations for the Mariner Jupiter/Saturn 1977 dual spacecraft mission, later named Voyager. A finite-element analysis was performed to simulate how various components of the spacecraft structure, as well as the structure as a whole, reacted under different physical stresses. The different models were tested using a computer simulation. The computer program used was NASTRAN (NASA Structural Analysis Program). NASTRAN continues to be the leading finite-element analysis program, with a current version number in the 70s. There were many different spacecraft configurations tested, before a proof-test model was assembled.

Also represented in the collection are folders involving the Viking and Helios missions. The files deal with various similar test procedures, most notably the Vibration Data Analysis Test, that analyzed the impact of various physical stresses on computer and test models of the spacecraft and the launch vehicle.

The collection is divided into 6 series: Voyager Plots and Loads Analysis, Voyager Vibration Data Analysis, Titan IIIE/Centaur Loads Analysis Reports, Miscellaneous Voyager Materials, Viking Materials, and Helios Materials. While two files involving Viking are dated from 1971, the bulk of the collection is between 1974-1976.

Voyager Plots and Loads Analysis (folders 1-47). This series consists primarily of copies of computer printouts and computer plots. Some correspondence and handwritten notes are also included. The composite model of a spacecraft consists of an assembly of discrete models of each of the following components: antenna, radioisotope thermoelectric generator (RTG), science platform, bus, propulsion system, and adapters. Each component was modeled and tested in each spacecraft configuration. The potential stresses upon each element of the spacecraft, including stresses of the launch on the spacecraft, were modeled on a computer using NASTRAN. The raw data used in the program was documented in the load analysis of each configuration. The load analyses included a modal analysis, 4G and 10G pseudo static axial loads, stage 1 burnout, joint loads, element stresses at launch, and relative stresses at launch and at stage 1 burnout. A few configurations had minimum stress loads plotted out, such as a launch with a minimum of 1G, which would be the spacecraft and launch vehicle just sitting on the launch pad.

Voyager Vibration Data Analysis (folders 48-58). The materials in the series include primarily graphs, although there are also tables, correspondence and handwritten notes. A vibration data analysis was essential in testing the durability of spacecraft, and continues to be an essential test.

Titan IIIE/Centaur Loads Analysis Reports (folders 59-85). Included in the collection are reports and copies of computer printouts. Much of the information in the series is similar to the Voyager Plots and Loads Analysis series. Conducting tests on the launch vehicle was just as important as conducting tests on the spacecraft. The vast majority of the reports in the series originated at Martin Marietta, the main contractor for the Titan III/Centaur launch vehicle.

Miscellaneous Voyager Materials (folders 86-97). The materials in the series include reports and handwritten notes of miscellaneous Voyager materials that refer to specifications and tests of various components in the spacecraft, including two folders pertaining to the RTG units. The load limits and interface specifications of the RTGs are addressed.

Viking Materials (folders 98-118). The Viking materials are similar to the miscellaneous Voyager materials. Most of the items concern vibration tests. The Viking stress tests were also of help to preliminary designs of the Voyager spacecraft. There were also a number of test failures, most notably involving the propellant tank, which is the subject of two folders in the series.

Helios Materials (folders 119-124). This collection includes reports, correspondence, and handwritten notes. Most of the Helios material deals with integration of the Helios spacecraft with the Titan IIIE/Centaur launch vehicle.

Oversize Materials (folders 125-134). The oversize materials consist of computer printouts. Included are two Mariner Jupiter/Saturn (Voyager) configurations not represented in any of the previous folders.

## **Conservation/Preservation**

Standard preparations of documents for long term storage were completed.

## **Separation Statement**

The original accession (1989-11) was split up into eight separate collections: Spacecraft Configuration Testing Collection (this collection), Office of the Director Collection (JPL 142), JPL Executive Council Collection (JPL 150), U.S. Army Projects Collection (JPL 154), Radio Science Collection (JPL 155), Deep Space Network Hardware Collection (JPL 156), Mariner Mars Contractor Reports Collection (JPL 160), and the Optical Image Enhancement Feasibility Study Collection (JPL 161).

## **Finding Aids**

No other finding aids exist for the collection.

## **FILE FOLDER LIST**

### **Box 1 of 18 – Voyager Plots and Loads Analysis**

- Fld. 1 Mariner Jupiter/Saturn Loads Analysis, Configuration 4, with Summary, May 1974.
- Fld. 2 MJS Plots, Configuration 5.0, August 5, 1974.
- Fld. 3 MJS Loads Analysis, Configuration 5.0, August 1974.
- Fld. 4 MJS Plots, Configuration 5.5, September 14, 1974.
- Fld. 5 MJS Loads Analysis, Configuration 5.5, September 1974.
- Fld. 6 MJS Plots, Configuration 6.0, November 26, 1974.
- Fld. 7 MJS Loads Analysis, Configuration 6.0, December 1974.
- Fld. 8 MJS Plots, Configuration 6.6, January 10, 1975.
- Fld. 9 MJS Loads Analysis, Configuration 6.6, January 1975. [folder 1 of 3]

### **Box 2 of 18**

- Fld. 10 [folder 2 of 3]
- Fld. 11 [folder 3 of 3]
- Fld. 12 MJS Plots, Configuration 6.7, March 23, 1975.
- Fld. 13 MJS Loads Analysis, Configuration 6.7, March 1975. [folder 1 of 3]
- Fld. 14 [folder 2 of 3]
- Fld. 15 [folder 3 of 3]
- Fld. 16 MJS Plots, Configuration 6.9, April 5, 1975.

### **Box 3 of 18**

- Fld. 17 MJS Loads Analysis, Configuration 6.9, April 1975. [folder 1 of 5]
- Fld. 18 [folder 2 of 5]
- Fld. 19 [folder 3 of 5]
- Fld. 20 [folder 4 of 5]
- Fld. 21 [folder 5 of 5]
- Fld. 22 MJS Plots, Configuration 6.11, April 29, 1975.

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- Fld. 23 MJS Loads Analysis, Configuration 6.11, April 1975. [folder 1 of 4]
- Fld. 24 [folder 2 of 4]
- Fld. 25 [folder 3 of 4]
- Fld. 26 [folder 4 of 4]
- Fld. 27 MJS Loads Analysis, Minimum Loads, Configuration 6.11, May 20, 1975. [folder 1 of 2]
- Fld. 28 [folder 2 of 2]
- Fld. 29 MJS Loads Analysis, Configuration 6.11, n.d.

### **Box 5 of 18**

- Fld. 30 MJS Plots, Configuration 6.12, September 1975. [folder 1 of 2]
- Fld. 31 [folder 2 of 2]
- Fld. 32 MJS Loads Analysis, Configuration 6.13, July 22, 1975. [folder 1 of 3]
- Fld. 33 [folder 2 of 3]
- Fld. 34 [folder 3 of 3]
- Fld. 35 MJS Model 6.12, Mode Shapes/Plots, July 20, 1975.

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Fld. 36 MJS Loads Analysis, Configuration 6.13, November 1975. [folder 1 of 2]  
Fld. 37 [folder 2 of 2]  
Fld. 38 MJS Plots, Configuration 6.14, November 10, 1975.  
Fld. 39 MJS Loads Analysis, Configuration 6.14, November 1975. [folder 1 of 3]  
Fld. 40 [folder 2 of 3]

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Fld. 41 [folder 3 of 3]  
Fld. 42 MJS Plots, Configuration 6.14, December 7, 1975.  
Fld. 43 MJS Sine Test Configuration, Mode Plots, February 9, 1976. [folder 1 of 2]  
Fld. 44 [folder 2 of 2]  
Fld. 45 MJS System Modal, Mode Points, February 10, 1976. [folder 1 of 2]  
Fld. 46 [folder 2 of 2]  
Fld. 47 MJS Loads Analysis, Configuration 6.15, June 15, 1976.

**Box 8 of 18 – Voyager Vibration Data Analysis**

Fld. 48 MJS Special Type Approval, Vol. I, Vibration Data Analysis, 1976.  
[folder 1 of 3]  
Fld. 49 [folder 2 of 3]  
Fld. 50 [folder 3 of 3]  
Fld. 51 MJS Special Type Approval, Vol. II, Vibration Data Analysis, 1976.  
[folder 1 of 3]  
Fld. 52 [folder 2 of 3]  
Fld. 53 [folder 3 of 3]

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Fld. 54 MJS Swept-Sine Vibration Data Analysis, 1976. [folder 1 of 3]  
Fld. 55 [folder 2 of 3]  
Fld. 56 [folder 3 of 3]  
Fld. 57 MJS Special Test Article, Swept-Sine Vibration Data Analysis, June 1976.  
[folder 1 of 2]  
Fld. 58 [folder 2 of 2]

**Titan IIIIE/Centaur Loads Analysis Reports**

Fld. 59 Titan IIIIE/MJS Stage 1 Burnout Loads Analysis, MJS Spacecraft Model 5.5, December 17, 1974.  
Fld. 60 Titan IIIIE/MJS Aerodynamics Loads Analysis, Spacecraft Model 5.5, December 1974.  
Fld. 61 Preliminary Submittal, Titan IIIIE/MJS Spacecraft Aerodynamic Loads Analysis, MJS Spacecraft Model 5.5, January 24, 1975.  
Fld. 62 Titan IIIIE/MJS Additional Spacecraft, Shared Clearance Loss Analysis and Launch for Airloads, MJS Spacecraft Model 5.5, March 27, 1975.  
Fld. 63 Titan IIIIE/MJS Launch Loads Analysis, MJS Spacecraft Model 6.11, August 7, 1975.

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Fld. 64 Martin Marietta, Launch Vehicle Mass Properties Report: Titan IIIIE/MJS Class Configuration,” September 25, 1975.

Fld. 65 Titan IIIE/Centaur, MJS Systems Integration Engineering, Load History and Comparison, 1975-1976.

Fld. 65A Titan IIIE/MJS, D-1 Centaur Equipment Module, Structural Test Evaluation Report, March 25, 1976.

Fld. 66 Titan IIIE/MJS Aerodynamic Loads Analysis, MJS Spacecraft Model 6.15, November 10, 1976.

Fld. 67 Titan III/Centaur Loads Data Book, Vol. 2, Basic Data, Change 14, April 23, 1977.

Fld. 68 Titan III/Centaur Loads Data Book, Vol. 3, Integrated Data, Change 14, Part 1, April 28, 1977. [folder 1 of 3]

Fld. 69 [folder 2 of 3]

Fld. 70 [folder 3 of 3]

Fld. 71 Titan III/Centaur Loads Data Book, Vol. 3, Integrated Data, Change 14, Part 2, April 28, 1977. [folder 1 of 2]

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Fld. 72 [folder 2 of 2]

Fld. 73 Titan III/Centaur Loads Data Book, Vol. 3, Integrated Data, Change 14, Part 3, April 28, 1977. [folder 1 of 3]

Fld. 74 [folder 2 of 3]

Fld. 75 [folder 3 of 3]

Fld. 76 Titan III/Centaur Loads Data Book, Vol. 3, Integrated Data, Change 14, Part 4, April 28, 1977. [folder 1 of 3]

Fld. 77 [folder 2 of 3]

Fld. 78 [folder 3 of 3]

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Fld. 79 Titan III/Centaur Loads Data Book, Vol. 4, Results, Change 12, Part 1, April 28, 1977. [folder 1 of 3]

Fld. 80 [folder 2 of 3]

Fld. 81 [folder 3 of 3]

Fld. 82 Titan III/Centaur Loads Data Book, Vol. 4, Results, Change 12, Part 2, April 28, 1977. [folder 1 of 2]

Fld. 83 [folder 2 of 2]

Fld. 84 General Dynamics, Convair Division, "Radio Postflight Data Evaluation Plan for Voyager (MJS77) Launch Vehicle TC-7," July 14, 1977.

Fld. 85 Titan IIIE/MJS77, Launch Vehicle Final Data Review Presentation Material, TC-7 Flight, August 27, 1977.

#### Miscellaneous Voyager Materials

Fld. 86 Tom E. Gindorf, "Mariner Jupiter/Saturn 1977 Spacecraft System, Environmental Program, Policy and Requirements, PD 618-228, April 27, 1973.

Fld. 87 Mariner Jupiter/Saturn 1977 Spacecraft Quality Assurance Plan, PD 618-215, November 12, 1974.

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Fld. 88 MJS Adapters, by Volkert, 1974-1976. [folder 1 of 3]

Fld. 89 [folder 2 of 3]

Fld. 90 [folder 3 of 3]

Fld. 91 MJS Model 6.15 Aerodynamic Loads Notes, December 21, 1976.

Fld. 92 MJS, RTG, Vol. 2- Load Limits, Joint Launch, Interface Specification,

1976. [folder 1 of 2]  
 Fld. 93 [folder 2 of 2]  
 Fld. 94 MJS 77 TVC Notebook, 1976. [folder 1 of 2]  
 Fld. 95 [folder 2 of 2]

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Fld. 96 MJS Analysis and Brackets, K. J. Volkert, 1976.  
 Fld. 97 Voyager, Stage II Burnout Loads, 1977.

Viking Materials

Fld. 98 M. Salama, "Solar Panel Model Used in Spacecraft Models II, III, IV and V, December 1971.  
 Fld. 99 J. Chisholm, "Scan Platform Model Used in Spacecraft Models II, III, IV and V, December 1971.  
 Fld. 100 Viking Orbiter, Proof Test Failure of Propellant Tank, August-September 1972.  
 Fld. 101 Kenton Beall, Viking Orbiter 75 Scan Platform Model No. 5, September 1972.  
 Fld. 102 Viking Orbiter, Overall Buckling Tab and Truss, 1972.  
 Fld. 103 Viking Orbiter, Weld Area, Residual Stress, 1972.  
 Fld. 104 Viking Orbiter 75, Propulsion System, Tab Summary, 1972.  
 Fld. 105 Viking Orbiter 75, Spacecraft/Centaur Separation, 1972-1973.  
 Fld. 106 Viking Orbiter, Tank Weld, 1972-1973.  
 Fld. 107 W. C. Dunn, "Failure Report- VO'75 Propulsion Propellant Tank, Serial No. 001, January 2, 1973.

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Fld. 108 R. Mathews, "Viking 1975, Analytical Simulation of the Viking 1975 Forced Vibration Test," PD 611-57, April 1973.  
 Fld. 109 Viking Orbiter '75, Forced Vibration Test, July 1973.  
 Fld. 110 Langley Working Paper, "Stress Analysis and Experimental Results for a Sub-Scale Model of a Viking Orbiter Tank," August 27, 1973.  
 Fld. 111 M. Salama, "Modal Test for the Complete Viking 75 Honeycomb Solar Panel," December 1973.  
 Fld. 112 Viking Orbiter, Propulsion Test Deflections, 1973.  
 Fld. 113 Viking Orbiter 75 Scan Platform Model, PD 611-107, June 20, 1974.  
 Fld. 114 J. Fortenberry, G. R. Brownlee, "Viking Mars Lander 1975 Dynamic Test Model/Orbiter Developmental Test Model Forced Vibration Test, Summary Report," TM 33-689, November 15, 1974.  
 Fld. 115 Gerald R. Brownlee, Fred D. Day III, John A. Garba, "Analytical Prediction and Correlation for the Orbiter During the Viking Spacecraft Sinusoidal Vibration Test," *The Shock and Vibration Bulletin*, June 1975.  
 Fld. 116 "Flight Data Obtained from Viking A During the Titan and Centaur Powered Flight," PD 611-126, October 1975.  
 Fld. 117 Viking Orbiter Propellant Tank Stress In Sine Test, n.d.  
 Fld. 118 Viking Orbiter, Comm Channel Vibration Test, n.d.

**Box 16 of 18 - Helios Materials**

Fld. 119 Titan IIIIE/ Helios Additional Launch Transient Reconstruction Analysis, July 16, 1975.  
 Fld. 120 Martin Marietta, Titan IIIIE/Helios Additional Launch Transient

Reconstruction Analysis, July 25, 1975.

- Fld. 121 M. Trubert, A. Egwuatu, "Helios TC-2, Stage Zero, Ignition Pulse Reconstruction for MJS '77 Loads Analysis," PD 618-426, August 1, 1976.
- Fld. 122 D-1A Equipment Module Structure Test, NASA Technical Memorandum Rough Draft, 1976.
- Fld. 123 MMA Release Device Bolt Escape Problem, September 14, 1976.
- Fld. 124 K. J. Volkert, "Quick Look Failure Analysis of Injector P/N 10041605," n.d.

**Box 17 of 18 - Oversize Materials**

- Fld. 125 MJS Configuration 6.8, Mode Analysis, March 28, 1975.
- Fld. 126 MJS Configuration 6.10, Modal Stresses and Plots of Modes, April 22, 1975. [folder 1 of 9]
- Fld. 127 [folder 2 of 9]
- Fld. 128 [folder 3 of 9]
- Fld. 129 [folder 4 of 9]

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- Fld. 130 [folder 5 of 9]
- Fld. 131 [folder 6 of 9]
- Fld. 132 [folder 7 of 9]
- Fld. 133 [folder 8 of 9]
- Fld. 134 [folder 9 of 9]

## CATALOG DESCRIPTION

Spacecraft Configuration Testing Collection, 1971-1977 (bulk 1974-1976).

6.0 cu. ft. (16 boxes and 2 oversize boxes; 135 folders)

The collection documents various test configurations for the Mariner Jupiter/Saturn 1977 dual spacecraft mission, later named Voyager. A finite-element analysis was performed to simulate how various components of the spacecraft structure, as well as the structure as a whole, reacted under different physical stresses. The different models were tested using a computer simulation. The computer program used was NASTRAN, a structural analysis program. There were many different spacecraft configurations tested, before a proof-test model was assembled.

Also represented in the collection are folders dealing with the Viking and Helios missions. The files deal with various similar test procedures, most notably the Vibration Data Analysis Test, involving putting various stresses on the spacecraft and the launch vehicle.

The collection is divided into 6 series: Voyager Plots and Loads Analysis, Voyager Vibration Data Analysis, Titan IIIIE/Centaur Loads Analysis Reports, Miscellaneous Voyager Materials, Viking Materials, and Helios Materials. The materials include computer printouts, charts, graphs, reports, handwritten notes and correspondence.

Finding aid available in the repository.

### Tracings

Jet Propulsion Laboratory – History  
Voyager Project  
Mariner Jupiter-Saturn Flyby  
Viking Spacecraft  
Helios Project  
Load Tests

NASTRAN  
Stress Analysis  
Structural Analysis  
Vibration Tests  
Titan 3 Launch Vehicle  
Martin Marietta  
Brownlee, Gary  
Salama, Moktar A.  
Trubert, Marc  
Volkert, Keith J.  
Wolfe, K.  
Bamford, Robert

Part of Accession 1989-11; Shipment #s 3677, 4266, 7350.